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To:	Wayne Praskins US EPA Region IX 75 Hawthorne Street San Fransisco, CA 94105-3901
From:	Matt McCullough/John Catts
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Attached please find your copy of the draft Phase II Work Plan. If you have any questions please contact John Catts at (415) 899-8825 or Matt McCullough at (714) 260-1800.

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DRAFT
Phase 2 Treatability Study Work Plan
Perchlorate in Groundwater
Baldwin Park Operable Unit
San Gabriel Basin

Engineering and Environmental Services

HLA

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Phase 2 Treatability Study Work Plan Perchlorate in Groundwater Baldwin Park Operable Unit San Gabriel Basin

Prepared for

Baldwin Park Operable Unit Steering Committee

HLA Project No. 39860.355

Kevin J. Trout
Project Engineer

John G. Catts, Ph.D.
Vice President

Matthew L. McCullough, P.E.
Vice President

May 20, 1998

HLA
Harding Lawson Associates
Engineering and Environmental Services
30 Corporate Park, Suite 400
Irvine, CA 92606 — (949) 260-1800

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1.0 INTRODUCTION

For the past several years, the Baldwin Park Operable Unit Steering Committee (BPOUSC), the U.S. EPA Region IX (U.S. EPA), Three Valleys Municipal Water District (TVMWD), and the Metropolitan Water District of Southern California (MWD) have been planning a combined groundwater remediation and water supply project in the San Gabriel Basin, California. Project planning was initiated in response to a requirement of U.S. EPA to remediate various plumes of volatile organic compounds (VOCs) in groundwater in the cities of Azusa and Baldwin Park. These plumes extend from north of Interstate 210 in the city of Azusa southwest to locations in the vicinity of Interstate 10 in the city of Baldwin Park. This area is called the Baldwin Park Operable Unit (BPOU).

The BPOUSC was in the process of negotiating agreements for the project with the U.S. EPA, MWD, and TVMWD when in June 1997, concentrations of perchlorate ion, above the State of California Department of Health Services (DHS) provisional action level of 18 micrograms per liter ($\mu g/L$), were found in BPOU groundwater. Before the project can move forward, the potential impact that perchlorate has on the conceptual project design must be evaluated. At the time it was discovered in BPOU groundwater, perchlorate was considered a particularly troublesome ion as there was no treatment technology that had been demonstrated to be effective in reducing concentrations of perchlorate to the provisional action level.

Treatability testing at a pilot-scale has been successfully performed at the Aerojet-General Corporation (Aerojet) facility near Sacramento, California. The technology can be described as a biological reduction process using a fixed film bioreactor. The fixed film is attached to granular activated carbon operated as a fluidized bed (GAC/FB). This pilot-scale test demonstrated that the technology was effective in treating perchlorate in groundwater. There were, however, several important differences between objectives of this previous pilot-scale work and current objectives for the BPOU project. First, the flow rate was 0.1 percent of that needed in the San Gabriel Basin. Second, the influent perchlorate concentration was over 100 times that expected in the San Gabriel Basin. Third, the pilot system was not designed to achieve nor did it achieve effluent perchlorate concentrations less than the 18 $\mu g/L$ provisional action level. Finally, the previous testing was not designed to deliver potable water.

In response to the need for further development of this biological reduction process, specifically for application in the San Gabriel Basin, a Phase 1 Treatability Study was performed at Aerojet's Sacramento, California, facility. This treatability study was performed between November 1997 and May 1998. The results of this study can be found in the report entitled *Draft Report, Phase 1 Treatability Study* (HLA 1997).

In summary, the Phase 1 Treatability Study demonstrated that the biological reduction method using GAC/FB technology successfully reduced low concentrations of perchlorate to concentrations below the 4 $\mu g/L$ laboratory reporting limit. At the same time, concentrations of nitrate were reduced from approximately 10 milligrams per liter (mg/L) (as nitrogen) to less than the laboratory reporting limit of 0.1 mg/L. Additionally, the alternative source of microorganisms used for the biological process also proved to be satisfactory in building the microbial population needed to destroy perchlorate and nitrate. Finally, the results of the treatability study indicate that the effluent water quality (following disinfection and filtration) should meet all applicable standards for use as potable water.

The knowledge gained over the 5 months of pilot plant operations identified the operating parameters that can be continuously monitored to achieve optimum system performance. For these parameters, operating limits that result in the destruction of perchlorate and nitrate were established. Operational controls (e.g., hydraulic retention time, percent recycled water, ethanol dose, and phosphorus dose) were also evaluated to establish the design criteria necessary to ensure successful treatment operations.

Although a considerable amount of knowledge was obtained from the Phase 1 Treatability Study, several important issues require further evaluation. The optimal Phase 1 pilot plant flow rate was 25 gallons per minute (gpm). To design a 20,000 gpm treatment system, the pilot-scale system must be scaled up to the unit size that will be part of the larger, full-scale system. At present, it is planned to use bioreactors that can accommodate a flow of 1,000 to 2,000 gpm. Therefore, a bioreactor process unit closer to this size will be constructed and tested in order to develop and verify the full-scale engineering design criteria.

San Gabriel Basin groundwater quality is also somewhat different from the water quality characteristics tested in Sacramento. Therefore, demonstration testing on groundwater that will be treated by the full-scale system is advisable before a commitment to build the full-scale system is made. Finally, the Phase 1 treatment system was not designed or operated to deliver potable water, and neither filtration or disinfection unit processes were tested.

The purpose of the Phase 2 Treatability Study is to design, construct, and operate a treatment system, based on the biological reduction technology developed by Aerojet, and to demonstrate perchlorate and nitrate destruction in the San Gabriel Basin groundwater at a scale that will allow the full-scale design of a perchlorate/nitrate treatment system for the Consensus Project.

The purpose of this Work Plan is to describe the approach and methods that will be used in performing Phase 2 treatability testing of the biological reduction technology in San Gabriel Basin at a site owned and operated by La Puente Valley County Water District (LPVCWD).

2.0 HISTORY OF PERCHLORATE ISSUES

In February 1997, perchlorate was discovered in five drinking water supply wells in Sacramento, California. This discovery was a result of a recent improvement in perchlorate analysis that allowed the detection of perchlorate in water at concentrations below the level that EPA and DHS consider acceptable for use by the public (18 μg/L). After the detection of perchlorate in Sacramento water supply wells, DHS performed perchlorate groundwater sampling and analysis in other portions of the state including the San Gabriel Basin.

2.1 Distribution of Perchlorate in the BPOU

Perchlorate was first detected in San Gabriel Basin groundwater in June 1997 by DHS. This prompted the Main San Gabriel Basin Watermaster (Watermaster) and the BPOUSC to perform additional groundwater sampling and analysis to better understand the distribution of perchlorate in groundwater.

To date, the BPOUSC has compiled perchlorate data for over 50 monitoring wells, production wells, and sampling points in the vicinity of the BPOU. Perchlorate analyses for water supply production wells were performed on samples obtained by the DHS and Watermaster and provided by the San Gabriel Basin Water Quality Authority (SGBWQA). Groundwater samples from monitoring wells in the BPOU were collected by Camp Dresser McKee (CDM), Harding Lawson Associates (HLA), and Geosyntec on behalf of the BPOUSC.

The lateral and vertical distribution of perchlorate in groundwater has been previously described (see *The Distribution and Treatability of Perchlorate in Groundwater, Baldwin Park Operable Unit, San Gabriel Basin* [HLA, 1997a], *Final Addendum to Sampling and Analysis Plan, Pre-Remedial Design Groundwater Monitoring Program, Baldwin Park Operable Unit, San Gabriel Basin* [HLA, 1997b], and " Draft Phase 2A Monitoring Well Installation and Groundwater Sampling Report, Baldwin Park Operable Unit, Pre-Remedial Design Program [HLA, 1998]). In general, the area that contains concentrations greater than the DHS provisional action level of 18 μg/L is 5 to 6 miles in length, oriented from northeast to southwest, is approximately 1 mile in width, and up to 800 feet in depth. This approximate perchlorate distribution is based on maximum concentrations detected in any sample or at any depth within a given well.

It should be noted that there is uncertainty regarding the concentrations above the 18 μg/L provisional action level in both the northernmost and southernmost portions of the plume. It should also be noted that there appear to be several sources of perchlorate in the San Gabriel Basin, and that there are anomalous detections in portions of the basin that cannot be explained or that may be the result of laboratory interferences.

Therefore, the known perchlorate distribution may change as wells are resampled or as new wells are constructed and sampled.

2.2 Toxicity/Provisional Action Level

In February 1997, the DHS set a provisional action level for perchlorate in groundwater at 4 μg/L, but at that time, laboratory methods were not designed or approved to measure concentrations this low. In May 1997, DHS, based on the results of U.S. EPA's recommendations, revised its provisional action level from 4 μg/L to 18 μg/L. DHS stated that it had reevaluated scientific studies in greater detail and had determined that 18 μg/L is consistent with the range of perchlorate exposures the U.S. EPA considers protective of human health. DHS requires that water suppliers promptly notify customers whenever perchlorate is present in concentrations greater than 18 μg/L.

In April 1993, the Perchlorate Study Group (PSG) was formed by the U.S. Air Force, various aerospace companies, and the two primary manufacturers of perchlorate compounds. The mission of the PSG was to review and evaluate information on the toxicity of perchlorate and develop better information on what constitutes an acceptable level of perchlorate in soil and groundwater. More recently (1997), the PSG undertook to perform the toxicological studies needed to develop a provisional RfD that will be more reflective of exposure to low levels of perchlorate in water. Results are expected late in 1998 and can then be used to calculate a recommended MCL.

3.0 PERCHLORATE TREATMENT BY BIOLOGICAL REDUCTION

In response to the presence of perchlorate in groundwater at Aerojet's Sacramento facility, a considerable amount of work has been performed to address perchlorate treatability. This work has included technology screening, bench-scale studies, pilot-scale studies, and the design of a full-scale (4,000 gpm) system. The work was performed by Aerojet and a consultant starting in 1994 and is described in other documents (HLA 1997a, 1997b, 1998).

Biological reduction of perchlorate involves a microbial reaction in which perchlorate is biochemically reduced to chloride carbon dioxide and water, with the simultaneous biochemical oxidation of an organic substrate. The substrate is typically selected based on being readily biodegradable, nonhazardous, low in cost, and readily available.

Biological treatment technologies generally fall into two classes: suspended-growth and attached-growth (fixed-film). Attached-growth systems are expected to be better suited to the relatively low influent perchlorate concentrations and are, therefore, the focus of previous treatability studies. Attached-growth systems can typically attain higher concentrations of microorganisms per unit reactor volume, and because the microorganisms are attached to media within the biological reactor, there is no requirement to recycle microbes to the treatment reactor.

The biological reduction technology is an attached-growth (fixed-film) process that utilizes granular activated carbon as a support medium for biological attachment and growth in a fluidized bed reactor. The GAC/FB technology offers the additional advantage of greater surface area on which microorganisms can attach and grow, as well as the presence of activated carbon, which provides some buffer capacity to varying operating conditions. Groundwater, amended with an organic substrate (e.g., alcohol) and nutrients (nitrogen and phosphorus), is added to the treatment bed. As groundwater passes through the system, the microorganisms derive energy from the oxidation of the organic substrate, simultaneously reducing nitrate and perchlorate. Thus, the microorganisms multiply to a steady-state level, determined by the organic loading to the system.

Nonviable microorganisms eventually become detached from the medium and exit the system in the effluent, allowing new microorganisms to attach and reproduce. The reaction takes place under anoxic conditions; therefore, no air or oxygen (other than that contained in the influent water) is introduced to the system.

3.1 Phase 1 Treatability Study

The objectives of the Phase 1 treatability study were to evaluate the performance of the biological reduction treatment technology previously tested at Aerojet's Sacramento facility with the following modifications:

- Decrease the concentration of perchlorate in the influent to a concentration representative of that which will be present in San Gabriel Basin groundwater
- Increase the concentration of nitrate in the influent water to a concentration representative of San Gabriel Basin groundwater
- Achieve a lower perchlorate concentration in treatment plant effluent
- Test the effectiveness of an alternative source of microorganisms
- Evaluate the characteristics of the effluent to ensure drinking water quality

All these objectives were accomplished during Phase 1 testing. Results of the Phase 1 Treatability Study can be found in *Draft Report - Phase 1 Treatability Study* (HLA 1998b).

The Phase 1 Work Plan also identified several preliminary Phase 2 Treatability Study objectives. Several of these were either partially or fully achieved during Phase 1 testing. These included (1) determine the efficiency of perchlorate reduction, (2) evaluate required nutrients, (3) assess factors affecting biomass stability, and (4) evaluate relative bacterial preference for perchlorate and nitrate.

Previously cited Phase 2 objectives that were not addressed during Phase 1 testing included (1) assess the effect of various nitrate concentrations, and (2) establish filtration and disinfection requirements for potable water use.

3.2 Full-Scale System in Sacramento

Aerojet is in the process of constructing a full-scale perchlorate treatment system for one of the groundwater extraction and treatment systems at its Sacramento facility. The system is scheduled to be in operation in the fall of 1998. The hydraulic loading rate for the system is ultimately planned to be 4,000 gpm, although the initial phase will be 2,000 gpm. Four bioreactors will be constructed each with a design flow rate of 1,000 gpm. Each bioreactor will be 14 feet in diameter and 22 feet tall. It is expected that under normal operating conditions, the biomass will be 15 feet high. Effluent will flow through continuous backwash sand filters to remove biomass and particulates.

In late 1998, Aerojet's Sacramento perchlorate treatment unit should be on-line and several months of performance data should be available. Input from both Phase 1 and Phase 2 Treatability studies and performance data from Aerojet's Sacramento treatment unit will allow the BPOUSC to proceed with design of the full-scale treatment system for the BPOU Consensus Project.

4.0 PHASE 2 OBJECTIVES

The primary goal of this phase of treatability work is to collect the data necessary for the design and construction of a full-scale treatment unit that will be part of the BPOU consensus project treatment train, delivering potable water to water purveyors.

More specifically the objectives of this Phase 2 Treatability Study are to:

- Build and operate the biological treatment system at a flow rate that approaches the size of a treatment unit planned for the larger Consensus Project (500 to 1,000 gpm) and collect engineering design information
- Establish system operating parameters including those needed to assure optimal, reliable, and consistent bioreactor performance
- Filter and disinfect treatment plant effluent and monitor the quality of this effluent to assure that the water will meet drinking water standards
- Confirm destruction of perchlorate in the San Gabriel Basin groundwater matrix
- Confirm destruction of nitrate in the San Gabriel Basin groundwater matrix

4.1 Design, Build, and Operate a Treatment System That Will Allow Scaleup for the Consensus Project

The Phase 1 Treatability Study treatment system operated at a flow through rate of 25 gpm, yielding a hydraulic retention time of approximately 10 minutes. The extraction plan for the Consensus Project calls for the extraction of groundwater at a rate of 20,000 gpm. The entire flow will require treatment to remove VOCs, nitrate, and perchlorate.

To maximize the efficiency of treatment plant operations, perchlorate treatment will be performed in multiple bioreactors that can accommodate a portion of this entire flow. This will allow individual bioreactors to be taken out of service for routine maintenance without disrupting plant operations.

Bioreactor size will likely range between 500 gpm and 2,000 gpm capacities. The Phase 2 system capacity will fall within this range and will, therefore, allow testing of the bioreactor at a scale representative of that intended for the full-scale system.

4.2 Establish System Operating Parameters

A second objective of the Phase 2 Treatability Study is to design and refine the operating controls and monitoring systems that will allow the treatment system to run using surrogate parameters for predicting perchlorate concentrations in the bioreactor effluent. This is necessary because there is no real-time monitoring device that can be used to measure concentrations of perchlorate in water at the laboratory reporting level of 4 ug/L or the DHS provisional action level of 18 ug/L.

The Phase 1 Treatability Study Report (HLA, 1998) demonstrated that bioreactor performance could be predicted and controlled by monitoring for a limited number of parameters and adjusting system controls accordingly. The Phase 1 report specifically identified that operating performance could be predicted by monitoring the dissolved oxygen profile within the bioreactor and the redox potential in the bioreactor effluent. As long as an anoxic environment was achieved within the first 25 to 30 percent of the reactor bed depth, the bioreactor effluent was characterized by a redox potential of less than -200 mv, and complete destruction of perchlorate and nitrate was achieved.

If these conditions are not achieved, several operational actions can be implemented to restore complete perchlorate destruction efficiency. These include adjustment of influent dissolved oxygen through recycling bioreactor effluent which essentially increases hydraulic retention time or adjustment of nutrient and/or ethanol loading rates.

The Phase 2 Treatability Study bioreactor will include a system for obtaining real-time data for dissolved oxygen concentrations and redox potential within the bioreactor through the use of in-line monitoring devices.

4.3 Treated Water Drinking Water Quality

For the BPOU Consensus Project to be viable it must deliver potable water to water purveyors. The selected treatment processes, therefore, must produce water that meets all federal and state requirements for a drinking water supply. Because the system will include biological treatment of water and there is a potential that treated water may contain bacteria, all water leaving the bioreactor will be both disinfected and filtered. This level of treatment will be comparable to that performed routinely for surface water.

An objective of the Phase 2 Treatability Study is to establish disinfection and filtration requirements. The La Puente Valley County Water District (LPVCWD) facility is equipped to treat the entire flow using sodium hypochlorite. Characterization of disinfection by-products will be performed. A high-rate, multimedia filtration system will be added to the Phase 2 treatment train.

The source water and the effluent will be regularly tested for an appropriate range of water quality parameters including those specified in the Safe Drinking Water Act and the California Code of Regulations, Title 22.

In addition, the microorganism innoculum will be characterized and all additives will be certified for use in drinking water systems.

4.4 Confirm Perchlorate Destruction

Based on the distribution of perchlorate in San Gabriel Basin groundwater, the configuration of extraction wells and flow rates described in the December 1996 Pre-Remedial Design Report (CDM, 1996), and modifications to the extraction plan discussed with U.S. EPA, the BPOU groundwater extraction system is expected to contain perchlorate concentrations between 50 and 100 μg/L. This range was estimated by selecting surrogate wells for each extraction well location, assigning recently measured concentrations from each surrogate well to its corresponding extraction well, and flow-weighting these concentrations based on expected pumping rates to produce a flow-weighted average concentration for the BPOU extraction system. This method gives a rough estimation of concentrations that will be initially extracted. The actual concentrations present in the extracted groundwater will be confirmed after extraction wells are constructed and pumped at their design flow rate.

Concentrations of perchlorate in groundwater at Aerojet's Sacramento facility (Well 40-11), the well used as influent to the Phase 1 Treatability Study, ranged from approximately 30 to 60 μg/L. LPVCWD Well No. 2 is expected to contain approximately 100 μg/L perchlorate. Although the perchlorate concentrations expected at the LPVCWD well are sufficiently close to the range where the Phase 1 Treatability Study documented destructive performance, Phase 2 treatability testing will confirm perchlorate destruction at this concentration and using the actual groundwater quality characteristics present in the San Gabriel Basin. The system sensitivity to changes in influent concentration will also be examined.

4.5 Confirm Nitrate Destruction

The Phase 1 Treatability Study at Aerojet's Sacramento facility treated groundwater with nitrate concentrations ranging from 10 to 13 mg/L (as nitrogen). Under normal bioreactor operating conditions, the effluent nitrate concentration was less than 0.1 mg/L. This confirms that the reduction of nitrate is also occurring in the fixed-film bioreactor, along with the consumption of alcohol and the reduction of perchlorate.

The BPOU Consensus Project is expected to produce groundwater containing nitrate concentrations between 4 and 6 mg/L (as nitrogen). Although these concentrations are well below the 10 mg/L MCL, they are substantially higher than concentrations currently received by customers of MWD and TVMWD. The treatment system will, therefore, have a significant beneficial effect as both perchlorate and nitrate concentrations will be reduced.

Before a full-scale treatment system is constructed, confirmation of nitrate destruction is needed on San Gabriel Basin groundwater. The Phase 2 Treatability Study will provide this confirmation.

5.0 TREATMENT EQUIPMENT DESCRIPTION

This section contains a conceptual design for the Phase 2 Treatability Study treatment system. This conceptual design will be refined and modified during Phase 2 design.

The conceptual design of the BPOU Consensus Project central treatment plant includes biological reduction of perchlorate and nitrate followed by air stripping technology to remove VOCs with offgas treatment to control VOC emissions. For purposes of this Phase 2 treatability test, it has been assumed that perchlorate removal will occur prior to VOC removal. Therefore, for Phase 2 treatability testing, groundwater will first flow through the bioreactor and then VOCs will be removed with the use of one of two existing LPVCWD air strippers.

This system configuration offers several advantages over the placement of the bioreactor after the air strippers. First, air stripping before biological treatment will add dissolved oxygen to the water entering the bioreactor. This dissolved oxygen will need to be reduced to a concentration of 0.1 to 0.2 mg/L in order to establish the proper redox environment for perchlorate destruction. Removal of this dissolved oxygen will require a higher ethanol dosage and more retention time in the reactor, hence a reactor with greater capacity. Second, the water flowing from the bioreactor will be depleted in dissolved oxygen and will require aeration before introduction into a public water supply. The water will be aerated by placing the air stripper after the bioreactor.

There was an initial concern that biological treatment of water containing VOCs may produce unwanted by-products (e.g., vinyl chloride). The Phase 1 Treatability Study demonstrated that this is not the case and that air stripping can be performed following biological treatment.

The Phase 2 treatment system will include an extraction well, a bioreactor with granular activated carbon, a fluidization pump, a nutrient feed system, an ethanol/alcohol feed system, a biological growth control system, an equalization/ disinfection tank, assorted pumps, valves, sensors, and piping, and an air stripper with vapor phase carbon air emission control.

The extraction well will be LPVCWD Well No. 2. This well normally operates at a flow rate ranging from 500 to 1,200 gpm. The existing pump will not allow production at a rate less than 500 gpm; therefore, this is the minimum flow rate for the Phase 2 Treatability Study. It has been assumed for this Work Plan that the design flow rate for the treatment system will be 1,000 gpm. This rate may be reduced during the design process but will be at least 500 gpm.

An alcohol metering line, constructed of stainless steel tubing, will be connected to the bioreactor influent line. The alcohol will be added to the influent to provide a readily degradable carbon source for the microorganisms. The alcohol will be purchased under a permit from the Bureau of Alcohol, Tobacco and Firearms (ATF). Because the alcohol is flammable, the alcohol will be stored in a fire-rated outdoor storage tank that will contain an integral sump for spill control. The alcohol will be metered from storage tank using a hazardous duty diaphragm metering pump which is UL-listed for use in Class I, Group D, Division I hazardous locations. Containment around the metering pump will be provided for spill control. The flow rate of the alcohol will be measured with an in-line flow meter.

Ten sample ports will provide for the collection of water quality samples and measurement of field parameters at key locations throughout the treatment system. These ten sample ports will be located as follows:

1. Production Well No. 2 outflow
2. Bioreactor influent line after strainer, alcohol feed, nutrient feed, and recycle line
3. 25 percent of reactor height
4. 50 percent of reactor height
5. 75 percent of reactor height
6. Effluent line from bioreactor
7. Effluent from equalization/disinfection unit
8. Air stripper inlet line
9. Air stripper effluent line
10. Effluent from filtration unit

After the effluent exits the bioreactor, it will flow by gravity to an equalization/disinfection tank equipped with level controls. From the equalization tank, the effluent will be pumped to the air stripper with disinfection occurring enroute. It is not anticipated that the biomass particulate in the treatment water will impact the operation of air stripper.

The equalization tank pump will be a centrifugal end-suction pump. Operation of the effluent equalization tank pump will be controlled by high-high, high, and low-level switches in the equalization tank. When the high-high level switch is activated, a signal will be sent to close the influent line. The closed valve will eliminate flow to the bioreactor, which will then operate in recycle mode. In addition, the high-high level switch will act as a failsafe shutdown and signal the alcohol metering pump to turn off so that it no longer supplies alcohol to the influent line. When the high-level switch activates, the equalization tank centrifugal pump will be sent a signal to turn on, discharging the contents of the tank to air stripper. When the low-level switch activates, the equalization tank pump will be signaled to turn off. A flow meter will be installed to measure the instantaneous and total water flow treated by the system.

The existing LPVCWD facility has two air strippers: one approximately 8 feet in diameter and 30 feet tall and one approximately 10 feet in diameter and 40 feet high, each of which has a capacity of 1,500 gpm. One of these two air strippers will be used for the Phase 2 Treatability Study. Operation of the air stripper will be optimized and made as efficient as possible.

Filtration of the treatment system effluent will be necessary before discharge to the LPVCWD water supply. Therefore, selection and testing of filtration system will be performed during the Phase 2 Treatability Study. Multimedia filtration using filter loading rates of between 4 and 6 gpm per square foot will be evaluated for performance effectiveness. Based on initial treatability results, higher filter loading rates may be considered for further evaluation. The filtration system will include a filter-aid polymer feed system and turbidity meters.

A generalized block flow diagram for the Phase 2 treatment system is presented as Figure 5-1. A generalized process flow diagram for this system is presented as Figure 5-2. A preliminary site layout that shows locations of existing LPVCWD equipment and potential locations for additional Phase 2 Treatability Study equipment is contained in Figure 5-3.

6.0 TREATMENT SYSTEM DESIGN

During the treatment system design, the specific components and configuration of the treatability testing equipment will be determined. Sets of equipment and construction specifications will be prepared and included in detailed design drawings. A detailed construction schedule detailing major and minor task completion dates will be created. The system will be designed according to all applicable building, fire, mechanical, civil and electrical code. The design documents will be provided to the appropriate local agencies for plancheck review. Sixty days are required for the system design.

7.0 EQUIPMENT PROCUREMENT AND CONSTRUCTION

Once the system design has been completed a construction bid package will be assembled and sent to a list of qualified bidders. Once bids have been received they will be reviewed and the bid will be awarded subsequently. The chosen subcontractor will assist the design engineers in obtaining the specified equipment. Once the appropriate approvals and permits have been obtained construction will commence according to the detailed construction schedule. It is anticipated that approximately 5 months will be required to complete construction. During system construction, HLA and the subcontractor will coordinate all of the appropriate inspections from the involved agencies.

8.0 PERMITTING

A number of permits that must be obtained to build and operate the Phase 2 Treatability Study treatment system. Some of these permits must be secured prior to start of construction, others are needed before system startup, and others are needed before the system effluent can be introduced into the LPVCWD water supply. Some of the key permitting requirements are described below.

8.1 Construction Permits

Construction permits normally required from state and local agencies will be obtained once facility design has been completed.

8.2 Discharge Permit

During system startup, treated water may contain concentrations of perchlorate or other chemicals above state or federal drinking water standards. Because this water cannot be directly introduced into the LPVCWD water supply, this water will need to be stored or discharged. The conceptual project design includes provisions for discharge of this water to adjacent Walnut Creek. The LPVCWD already has a Walnut Creek discharge point and the Watermaster holds a discharge permit. The Watermaster will amend this permit or obtain a new permit from the Los Angeles Regional Water Quality Control Board. The permitting process has been initiated. The modified discharge permit must be secured before system startup.

8.3 Ethanol (ATF) Permit

To secure denatured alcohol in the volumes required to support bioreactor operation, a permit from the ATF is required. The permit application has been submitted to ATF. This permit must be secured before system startup.

8.4 Certification of Additives

All chemicals used in a public water supply must be produced by a manufacturer certified to produce those chemicals. Two entities can perform this certification: Underwriters Laboratories (UL) and the National Sanitation Foundation (NSF). Several chemicals needed in the normal operation of the bioreactor will require this certification. Following initial dialog with both certifying bodies regarding the chemicals to be used and the anticipated certification schedule, a selection will be made and certification procedures initiated. Initial certification procedures have been initiated. This permit will not be needed until produced water is to be introduced to the LPVCWD water supply.

8.5 DHS Operating Permit

An operating permit must be obtained from the DHS in order for the Phase 2 Treatability Study treatment system to produce water that can be introduced into the LPVCWD water supply. Securing this permit is the ultimate goal of the Phase 2 Treatability Study, and many of the planned activities, monitoring, and data interpretation are being performed to establish the level of confidence necessary for DHS to issue LPVCWD an operating permit for this facility.

9.0 PILOT SYSTEM OPERATION AND MAINTENANCE PLAN

9.1 System Startup and Operation

A detailed operating and maintenance (O&M) plan will be prepared concurrently with the design of the treatment system. The O&M plan will include a detailed testing and monitoring program for evaluating the performance effectiveness of the treatment plant. The general plan for the startup and operation of the system is described in the following section.

After bioreactor is constructed, it will be filled with water and hydraulically operated prior to adding carbon or microbial seed to ensure proper, leak-free operation. Next, the system will be drained and the GAC/FB reactor column will be filled with the recommended amount of granular activated carbon. The remaining free volume of the bioreactor will then be filled with process water and the microbial seed.

From this point forward system operation is separated into two periods. The first is the startup period, where microorganism growth and attachment occurs and basic bioreactor operating conditions are established. The startup period is planned for 2 weeks. The second period is referred to as the performance monitoring period, where system operating conditions are optimized and performance monitoring samples collected. The performance monitoring period is expected to last the remainder of the 6-month operating period.

During the startup period, the bioreactor will be operated in recycle mode for several days to allow for growth and attachment of the microorganisms to the GAC. During recycle mode, groundwater will not flow through the system. Batch additions of alcohol, nutrients, and perchlorate will be added on a regular basis to support the microbial growth. As an option, the bioreactor may be started up in a continuous flow through mode.

After sufficient time is allowed for microorganism attachment to begin, groundwater containing perchlorate and nitrate will be introduced to the bioreactor. The flow of groundwater will be gradually increased to the design rate for the treatability test. Initial flows will be relatively low, but as monitoring indicates the bioreactor has stabilized, the flow rate will be incrementally increased.

The flow rate and the alcohol dose will be adjusted during the startup period to establish a stable microbial population in the bioreactor. Nutrients will be added at a rate sufficient to satisfy microbial requirements.

To assist in establishing stable operating conditions during the startup period a profile of reactor conditions will be obtained. Profiles for DO and ORP will be used with results of water quality testing. DO and ORP will be measured using in-line monitors. Water samples will be collected from sample ports on the influent and effluent lines and at 25, 50, and 75 percent points of the bioreactor height. The profile of selected parameters and concentrations of selected ions including perchlorate will be evaluated to examine perchlorate destruction. These data will also be used to vary the alcohol and hydraulic loading rates in a controlled, step-like manner until the target organic loading rate is established.

Targeted analytical parameters will be measured before and after each change in operating conditions. Although it is anticipated that the system will respond rapidly to changes in influent quality, nutrient feed, or alcohol feed, approximately 24 hours will be allowed to pass, samples collected, and results interpreted before additional changes are made. Assuming 1 day turnaround for laboratory analysis, this will mean that operating changes will be made no more frequently than every 48 hours. This will ensure reactor stability and allow a better understanding of how changes in reactor operation impact effluent quality.

Once the microbial populations have been established and stable bioreactor operating conditions achieved, the system will be operated in the performance monitoring mode. System operating conditions will be optimized to match the feed rate for alcohol with perchlorate and nitrate destruction. The goal is to maximize perchlorate and nitrate destruction and produce effluent free of detectable alcohol.

HLA personnel will assume O&M responsibilities. O&M activities will be modified as necessary to ensure proper control and performance of the treatment system. A logbook will be maintained at the site for recording all operating activities and observations. The logbook will serve as a daily checklist to ensure that necessary maintenance, sampling, and observations are conducted.

9.2 Health and Safety Plan

A Site Health and Safety Plan, prepared by HLA, will govern the activities of all HLA workers at the site who are associated with the Phase 2 Treatability Study. This plan will be prepared after Work Plan approval but prior to system start up.

10.0 SAMPLING AND ANALYSIS PLAN

The sampling and analysis portion of the Phase 2 treatability study is divided into two phases: a system startup period and a performance monitoring period. During the startup period, the objective is to build and establish the necessary population of microorganisms. The monitoring of operational control parameters and sampling and analysis schedule for this period is designed to support this objective. Operating parameters will be monitored and data reviewed once each day. Water quality samples will be collected on a daily basis and these samples will be analyzed to ensure the microorganisms are receiving sufficient organic substrate and nutrients.

In addition, early in the first week one influent sample will be collected and analyzed to provide a complete characterization of the source water. In addition, the microorganism innoculum will be characterized. This testing will allow for modification of the analytical schedule if appropriate.

After steady-state operating conditions are reached, less frequent but regular review of performance monitoring data will be conducted

10.1 Field Data Collection

During the 2-week startup period, continuous monitoring of process control parameters will be performed to assure steady-state conditions while microorganism populations are increasing and stabilizing. The parameters to be measured using in-line monitoring devices include flow rate, dissolved oxygen (DO), pH, redox potential, and temperature.

10.2 Sample Collection

Ten sample ports will provide for the collection of water quality samples and measurement of field parameters at key locations throughout the treatment system. These ten sample ports will be located as follows:

1. Production Well No. 2 outflow
2. GAC/FB influent line after strainer, alcohol feed, nutrient feed, and recycle line
3. 25 percent of flow path in GAC/FB bioreactor
4. 50 percent of flow path in GAC/FB bioreactor
5. 75 percent of flow path in GAC/FB bioreactor
6. Effluent line from GAC/FB bioreactor
7. Effluent from equalization/disinfection unit
8. Air stripper inlet line
9. Air stripper effluent line
10. Effluent from filtration unit

The sampling and analytical schedules will be provided in a Sampling and Analysis Plan that will be attached to the Operations and Maintenance Plan prepared during the design phase of the treatability study.

Samples collected from the pilot treatment system will be in the form of discrete grab samples. Grab samples provide better control than composite samples for monitoring the effects that changes in influent quality and reactor operating conditions have on reactor performance.

After collection, VOC samples in zero-headspace vials will be inverted and inspected for the presence of bubbles. All samples will be placed into coolers for same-day transportation to the analytical laboratory. Influent and effluent samples will be stored and transported on ice to preserve the samples and to prevent cross contamination of samples. Upon arrival at the laboratory, the samples will be stored at 4°C in walk-in coolers. Samples collected on Sunday or holidays will be stored in a refrigerator onsite, as the laboratory is not open that day. Samples will be delivered to the laboratory as soon as possible.

Sample container selection and sample preservation techniques will comply with U.S. EPA guidelines detailed in SW-846. Sample tags indicating sample location, date and time of sampling, and the initials of the individual who collected the sample will be attached to each sample. Each sample will be logged onto a chain-of-custody form. Copies of all chain-of-custody forms generated during the pilot study will be kept on file and available for review.

10.3 Analytical Testing

The project laboratory will perform analyses for VOCs, ammonia-nitrogen, alkalinity, chloride, phosphate, BOD, COD, total suspended solids, total dissolved solids, turbidity, perchlorate, chloride, ammonia, nitrate, nitrite, sulfate, alcohol, metals, and bacteriology. The purpose of this testing is to confirm and control the effectiveness of perchlorate reduction.

Analytical testing will be conducted using the U.S. EPA approved methods. Detection limits for all parameters are below health based water quality (drinking water) standards where such standards exist.

10.4 Quality Assurance Project Plan

HLA's Quality Assurance Management Plan (QAMP) assures that appropriate measures will be taken to assure project data quality objectives (DQOs) are achieved and data integrity is maintained. In addition to DQOs, HLA's QAMP addresses methods for sample collection and handling, sample custody, the type and frequency of quality control samples, laboratory quality control procedures, methods for data verification, reduction, management and interpretation, record keeping and corrective actions.

For field activities approximately 5 percent of all samples will be collected as splits (duplicates). Sample splits (duplicates) and blanks will be submitted to the project laboratory on a more frequent basis during the startup period when samples are collected more frequently. Trip blanks will be used where laboratory contamination is a concern. Field blanks will be used where field contamination is a concern.

Quality control samples will be collected but less frequently during the performance monitoring period. Sample splits (duplicates) will submitted more frequently for analyses that are performed more frequently. All samples will be appropriately labeled and packaged and will be shipped to the project laboratory under chain of custody.

Analysis of samples by the project laboratory will be performed in conformance with laboratory QC procedures and QC procedures specified by each of the certified or approved analytical methods.

11.0 IMPLEMENTATION TEAM AND COMMUNICATION PLAN

11.1 Implementation Team

Activities described here will be implemented by the team shown on Figure 9-1. Individuals responsible for the implementation of the activities in this Work Plan: (1) are appropriately qualified and licensed, (2) have considerable knowledge of a range of treatment technologies and experience designing and performing bench-scale and pilot-scale treatability tests, and (3) are experienced with the methods and procedures including those related to health and safety and quality assurance required to perform the proposed work.

This treatability study will be performed by a team of personnel from HLA and Aerojet under the direction of BPOUSC co-chairpersons, Don Vanderkar and Steve Richtel.

11.2 Communication Plan

Communication during the implementation of this treatability work will be conducted in a manner to facilitate timely decision making and communication of work progress. Lines of communication are shown on Figure 9-1.

John Catts will serve as technical director for the work and be responsible for communicating work progress to the BPOUSC and U.S. EPA.

It is anticipated that work progress and results will be communicated via telephone conversations, meetings, written correspondence, and reports as described in Section 10.0.

12.0 SCHEDULE

This Work Plan was prepared in conformance with the schedule proposed by BPOUSC and prepared on February 11, 1998 with two exceptions. After discussions with HLA's design engineers, it was determined that 30 additional days would need to be added to the design and construction tasks. System design will be initiated immediately upon Work Plan approval by the EPA, DHS, MWD, and RWQCB.

Task Description	Task Completion Date
Draft Phase 2 Work Plan	5/20/98
EPA, DHS, MWD Review and approval	6/3/98
Phase 2 System Design	8/3/98
Phase 2 Procurement	9/14/98
Phase 2 Construction	2/3/99
Phase 2 Permitting	1/3/99
Phase 2 Startup	3/1/99
Phase 2 Operations	9/3/99
DHS Operating Permit	9/3/99
Draft Phase 2 Report	5/26/99

13.0 REFERENCES

CDM, 1996. *Draft Baldwin Park Operable Unit, pre-remedial design groundwater monitoring program, pre-remedial design report,* December.

HLA, 1997a. *The distribution and treatability of perchlorate in groundwater, Baldwin Park Operable Unit, San Gabriel Basin,* July 15,.

HLA, 1997b. *Final addendum to sampling and analysis plan, pre-remedial design groundwater monitoring program, Baldwin Park Operable Unit, San Gabriel Basin,* October 1.

HLA, 1998. *Draft Phase 1 Treatability Study Report, perchlorate in groundwater, Baldwin Park Operable Unit, San Gabriel Basin.*

FIGURES

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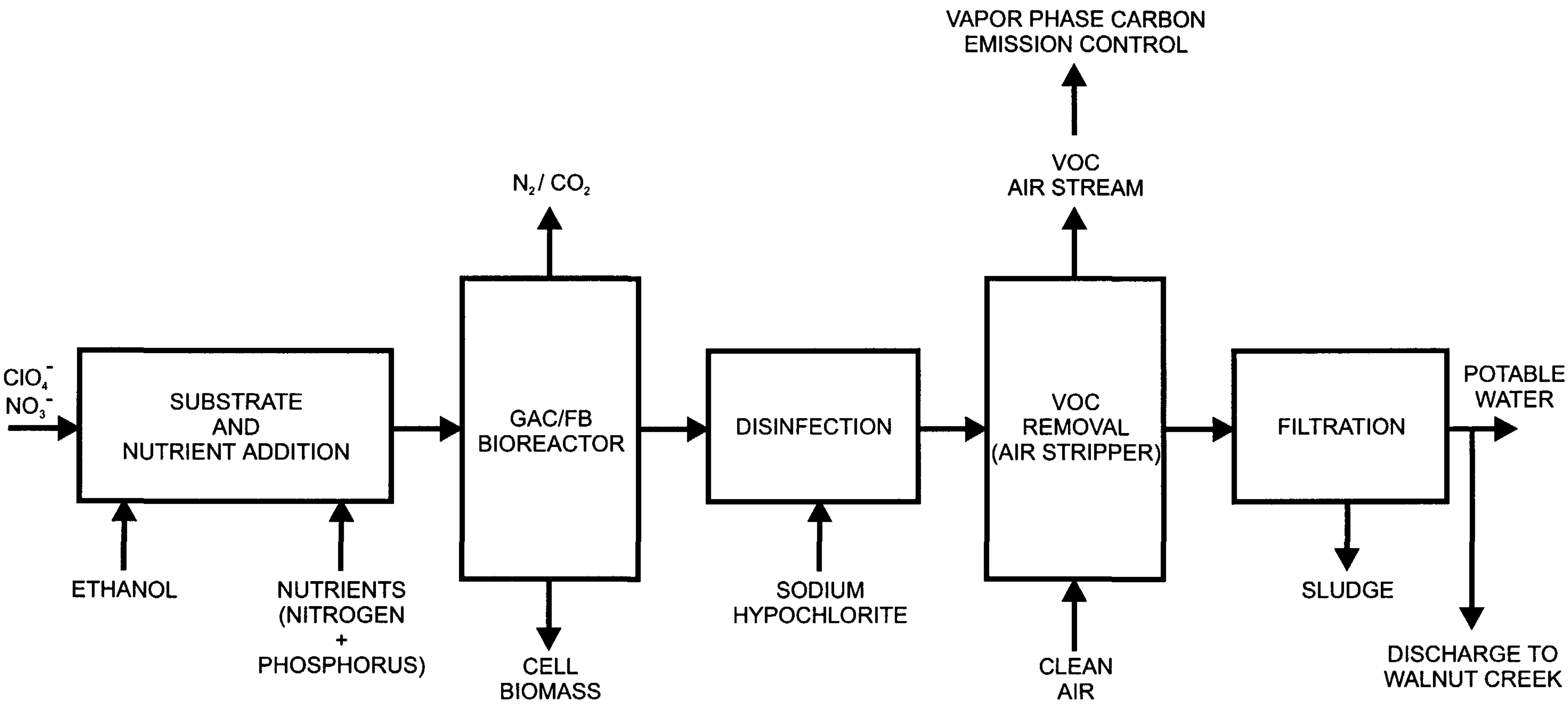

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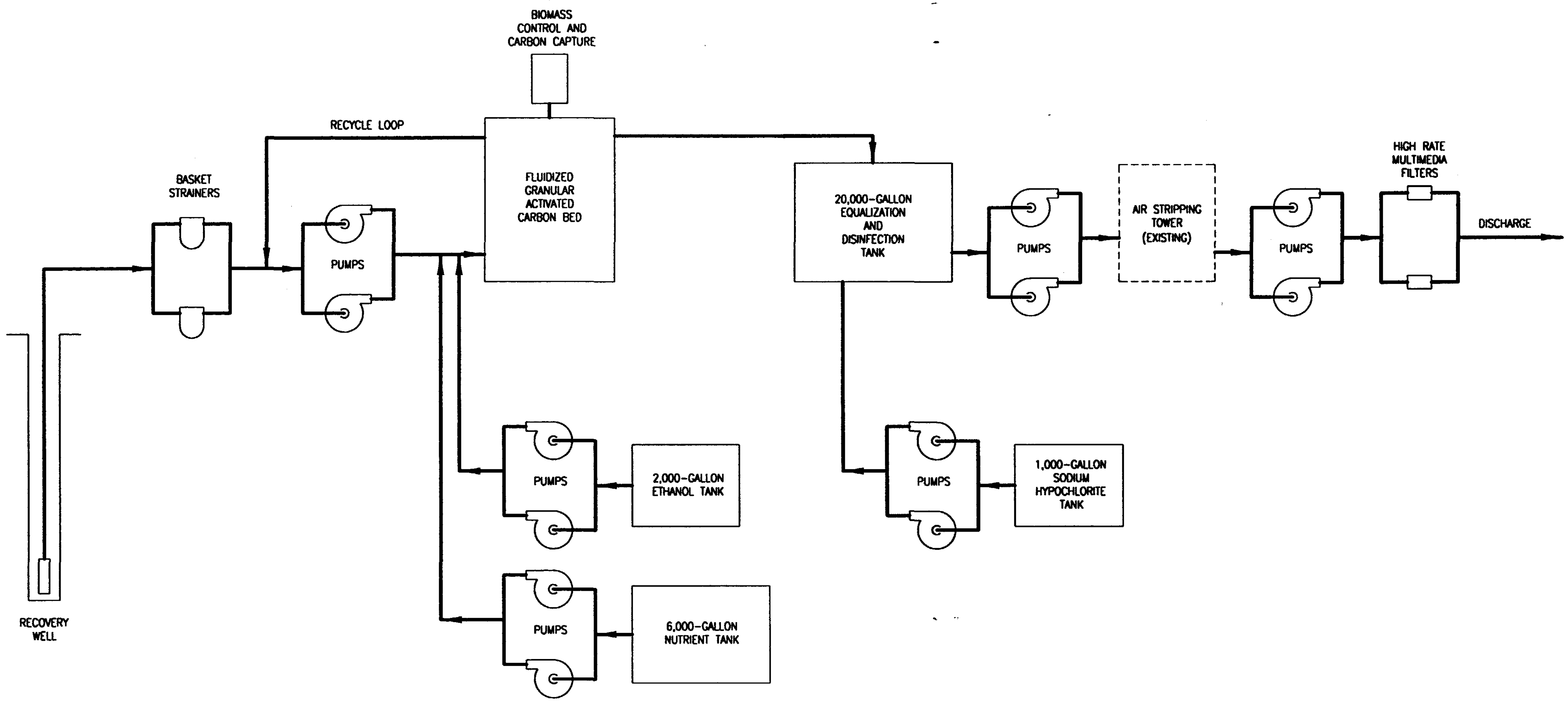
Environmental Services

IDEALIZED MASS FLOW DIAGRAM
Phase II Perchlorate Treatability Study
Baldwin Park, California

PLATE
5-1

DRAWN	PROJECT-TASK NUMBER	APPROVED	DATE	REVISED DATE
JTL	39860-355		5/98	



HLA	**Harding Lawson Associates** Engineering and Environmental Services		**IDEALIZED PHASE II TREATMENT SYSTEM** **PROCESS FLOW DIAGRAM** Phase II Perchlorate Treatability Study Baldwin Park, California	PLATE **5-2**
DRAWN JTL	PROJECT-TASK NUMBER 39860-355	APPROVED	DATE 5/98	REVISED DATE

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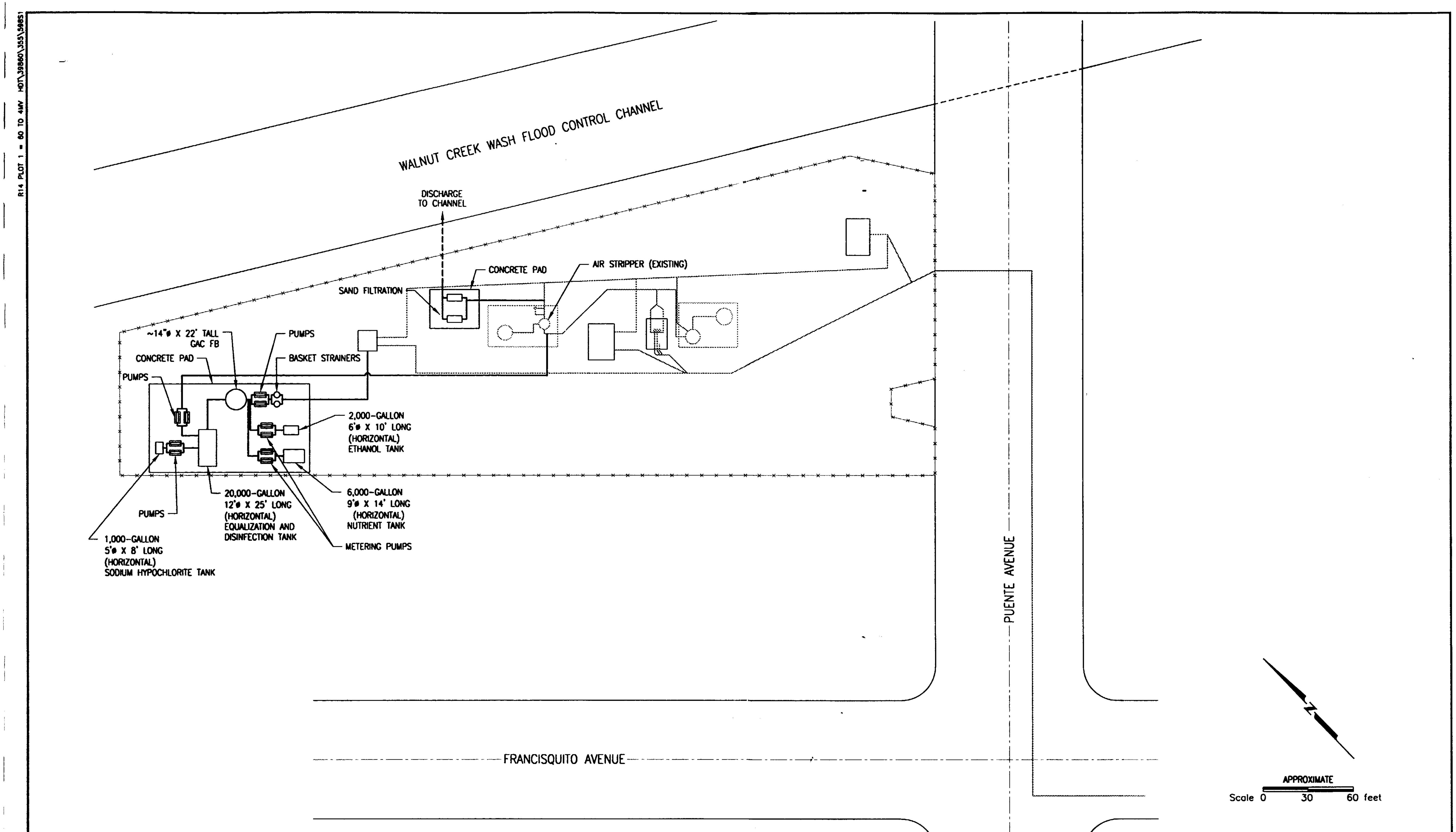

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Engineering and Environmental Services

CONCEPTUAL SITE LAYOUT
Phase II Perchlorate Treatability Study
Baldwin Park, California

PLATE
5-3

DRAWN	PROJECT-TASK NUMBER	APPROVED	DATE	REVISED DATE
JTL	39860-355		5/98	

Figure 12-1. Project Team